# Asymmetric response of precipitation to **ENSO in CMIP6 models**

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ENSO-precipitation asymmetry is a significant component of ENSO teleconnections in many 30°N regions. This study analyses this component in 46 AR6 regions and across 50 CMIP6 models 30°S identify seasonal and regional diversity in model performance.

46 AR6 Land Regions

	0.	Greenland/Iceland	18.	E.Europe	36.	Arabian-Peninsula
60°N	1.	N.W.North-America	19.	Mediterranean	37.	S.Asia
30 31 30 1	2.	N.E.North-America	20.	Sahara	38.	S.E.Asia
	3.	W.North-America	21.	Western-Africa	39.	N.Australia
33 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	4.	C.North-America	22.	Central-Africa	40.	C.Australia
34 35 4	5.	E.North-America	23.	N.Eastern-Africa	41.	E.Australia
	6.	N.Central-America	24.	S.Eastern-Africa	42.	S.Australia
	7.	S.Central-America	25.	W.Southern-Africa	43.	New-Zealand
38	8.	Caribbean	26.	E.Southern-Africa	44.	E.Antarctica
	9.	N.W.South-America	27.	Madagascar	45.	W.Antarctica
	10.	N.South-America	28.	<b>Russian-Arctic</b>		
	11.	N.E.South-America	29.	W.Siberia		
	12.	South-American-Monsoon	30.	E.Siberia		
42 12 12	13.	S.W.South-America	31.	Russian-Far-East		
0 43	14.	S.E.South-America	32.	W.C.Asia		
	15.	S.South-America	33.	E.C.Asia		
60°S	16.	N.Europe	34.	Tibetan-Plateau		
	17.	West&Central-Europe	35.	E.Asia		
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#### **Background and Motivation**

El Niño Southern Oscillation (ENSO) is a prominent climate phenomenon affecting the variability of regional precipitation. The precipitation response, during El Niño and La Niña phases, compared to neutral phase, are not mirror images of one another. In Australia, for instance, it gets much wetter during La-Nina, compared to the neutral phase, as it gets drier during El Niño, and this asymmetry plays an important role in drought breaks. There are few studies that analyse the seasonal differences in asymmetric response, while others do a global assessment of the regional differences in the asymmetric response. But there are no studies that analyse the ability of the CMIP6 models to simulate the seasonal and regional differences in the asymmetric response.

#### How well do models simulate annual asymmetry?

The figure below shows the regional diversity ENC, LNC and ASYMM components during the ANN. Simulated asymmetric response in the MMM is lower in magnitude but captures the spatial variability well especially particularly in Australia and Maritime Continent but not over Africa and Asia.

### **Data and Methods**

Observation data (OBS) : GPCP monthly precipitation data; HadISST data Reanalysis (REAN) : NOAA 20<sup>th</sup> Century Reanalysis precipitation. CMIP6 : 50 models including ACCESS-CM2 and ACCESS-ESM1.5



#### How well do models simulate seasonal asymmetry?

OBS (top) and REAN (middle)



## **Model Agreement for annual teleconnections**

Model Agreement fraction (MAF) represents the fraction of models (out of 50) that agree with the direction and stat. sign. of CORR (left) / ASYMM (right) in OBS [REAN for West and East Antarctica]. The black bars are regions where CORR is statistically significant. Reduced MAF for ASYMM is seen compared to CORR during ANN period.



#### **Reduced model agreement for seasonal asymmetry**

MAF for CORR and ASYMM are shown in the top and middle rows of the figure below with the difference between them shown in third row.

- MAF CORR is higher than MAF ASYMM during the ANN period and in all seasons in all regions where both CORR and ASYMM component are found to be statistically significant.
- This is especially apparent during the ENSO active seasons of SON and DJF.









## Conclusions

- Regional and seasonal diversity in asymmetric response is apparent.
- Model performance varies with seasons.
- Model agreement is higher (lower) for capturing teleconnections (asymmetry)